

**Space Weather Technical Forecast**

Issued on Sunday 13 October 2024 at 01:15 Local

**This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>**

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**Space Weather Forecast Headline: Chance G1 Minor Storm day 3 (15 Oct) from possible glancing CME arrival or coronal hole onset. Isolated M-class flares likely. Chance of Active electron fluence.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Low activity with peak flare C6.0 from the combined effect of the easing long period flare of ex-AR3847 over the southwest limb, and a further weak flare from AR3850. There are seven sunspot regions on the disc, with the largest of these AR3848 in the northwest. This persists as a large main spot, but with some complexity from an emerging opposite polarity spot to its north. AR3854 and AR3852 just east of the south-centre disc are also of interest. While relatively simple bipolar spots, the interaction between the two of them is potentially the cause of a bright area of magnetic flux visible between them in SDO imagery. The other regions remain simple, with the only notable growth being the two new regions just west of the north-centre and in the northeast.

No Earth-directed CMEs have been observed.

**Solar Wind / Geomagnetic Activity:** A disturbed geospace environment continued as solar winds eased since the 10 Oct CME arrival. Strong solar wind speeds, as observed at L1 by ACE, eased to elevated, from just below 700kms to around 570km/s. Density remained below average. Interplanetary magnetic field was initially Moderate at 12nT, but erratically eased to be Weak, falling to 1-4nT from 13/1200 UTC. The north-south component, Bz, was mainly positive (northward) with relatively brief spells of negative (southward) field, ranging +10 to -7nT. Phi angle was neutral and variable for much of the period, but became mainly negative from 12/2030 UTC. Geomagnetic activity was mainly at Quiet to Active but with one period of G1 Minor Storm (Kp5) at 12/0900-1200 UTC.

**Energetic Particles / Solar Radiation:** High energy proton flux observed by GOES18 was very near background and continued to ease. High energy electron flux (greater than 2MeV) observed by GOES16 was at Background until 12/1110 UTC, then rose to be Moderate with peak 432 pfu at 12/1230 UTC. The associated 24-hour fluence was below the Active threshold with a slight rising trend. The 12/2100UTC observed was 1.03e7.

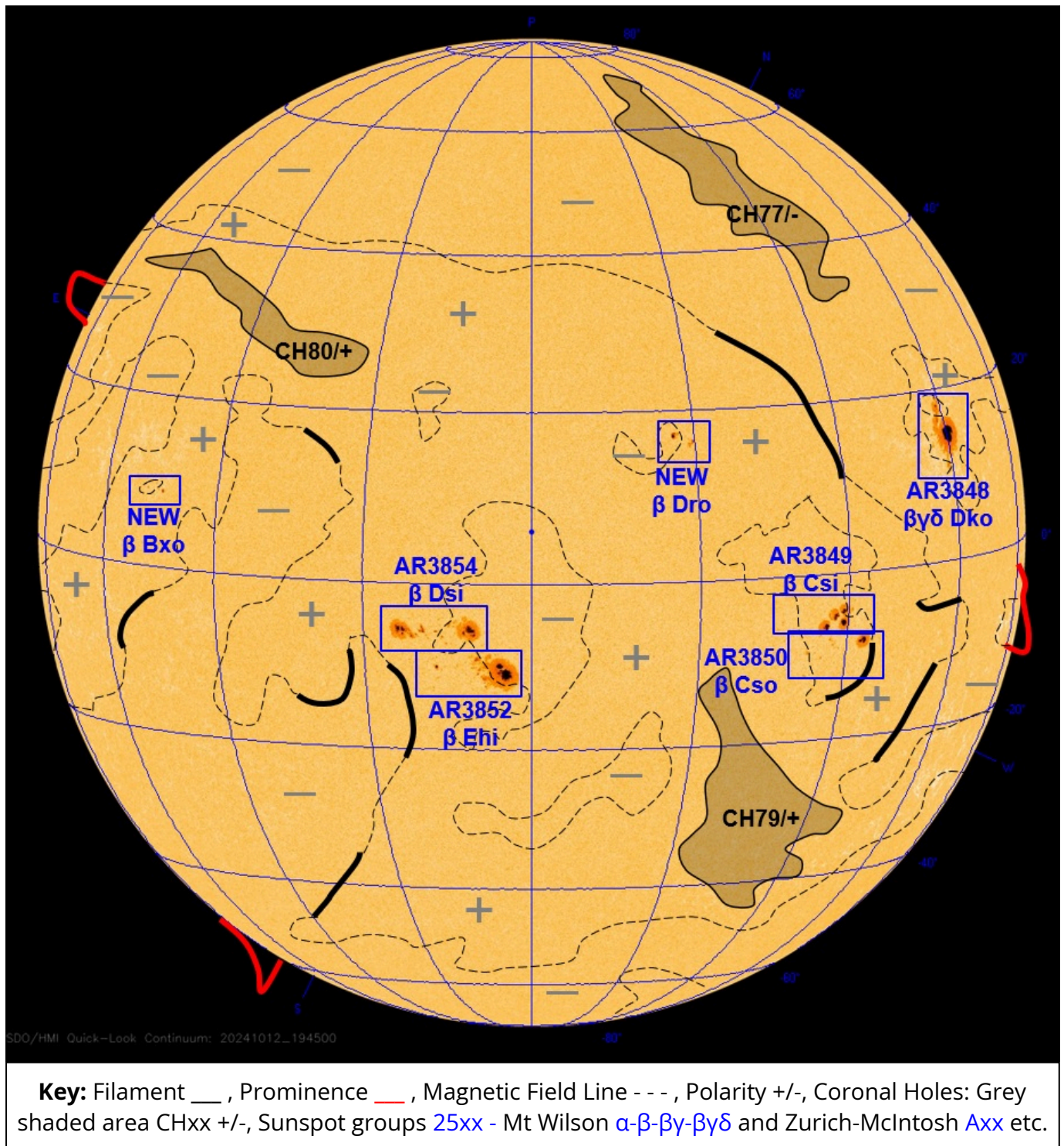
## Four-Day Space Weather Forecast Summary

**Solar Activity:** Low to Moderate activity is expected with a likelihood of isolated M-class flares and a slight chance of X-class flares.

**Solar Wind / Geomagnetic Activity:** There is a chance of a glancing impact from the CME early on day 3 (15 Oct). There are no other Earth-directed CMEs. Current disturbed geospace environment is expected to ease with slightly elevated winds declining to background. There is a slight chance of a fast wind enhancement from CH79/+ day 3 (15 Oct), however this is low confidence. Mainly Quiet to Active geomagnetic activity at first is expected to become mainly Quiet with Unsettled intervals, but with a chance of enhancement from coronal hole or CME effects, mainly on day 3 (15 Oct).

**Energetic Particles / Solar Radiation:** High energy proton flux observed by GOES-18 is now largely at background, but there remains a slight chance of further enhancements given any significant flares from AR3848 or potentially the combined AR3852/54. High energy electron flux is expected to continue rising as solar winds ease and the Van Allen belts expand outward again. This brings a chance of High flux, especially before any possible CME arrival or CH fast wind onset day 3 (15 Oct). The associated 24 hour fluence is expected to rise, with a chance of becoming Active ( $1e8$  total pfu), mostly likely day 2-3 (14-15 Oct)

**Figure 1: Solar Synoptic Map 12/2000UTC**



## Geomagnetic Storms

There is one potential Earth glancing CME. This originated from an M2.1 from from AR3854 in the east disc, with a glancing impact most likely on day 3 (15 Oct). This is low confidence, due to limited imagery for analysis, and the eastward directed CME, with much of the material passing behind (east of) Earth.

Otherwise, the ongoing elevated solar winds from the CME arrival on 10 Oct are expected to continue gradually easing towards background. There is a potential coronal hole fast wind onset from CH79/+ which is in the southern disc. This was present on the previous rotation, albeit slightly different in shape, and showed no notable enhancement. Confidence is Low, however, as MOSWOC Enlil is providing little guidance, as this is over-estimating the extent of a non-existent broad fast wind from the southern disc, likely due to current limitations with GONG H-alpha imagery that initialises the model. Overall there is a slight chance for a connection to this southern coronal hole, most likely on day 3 (15 Oct).

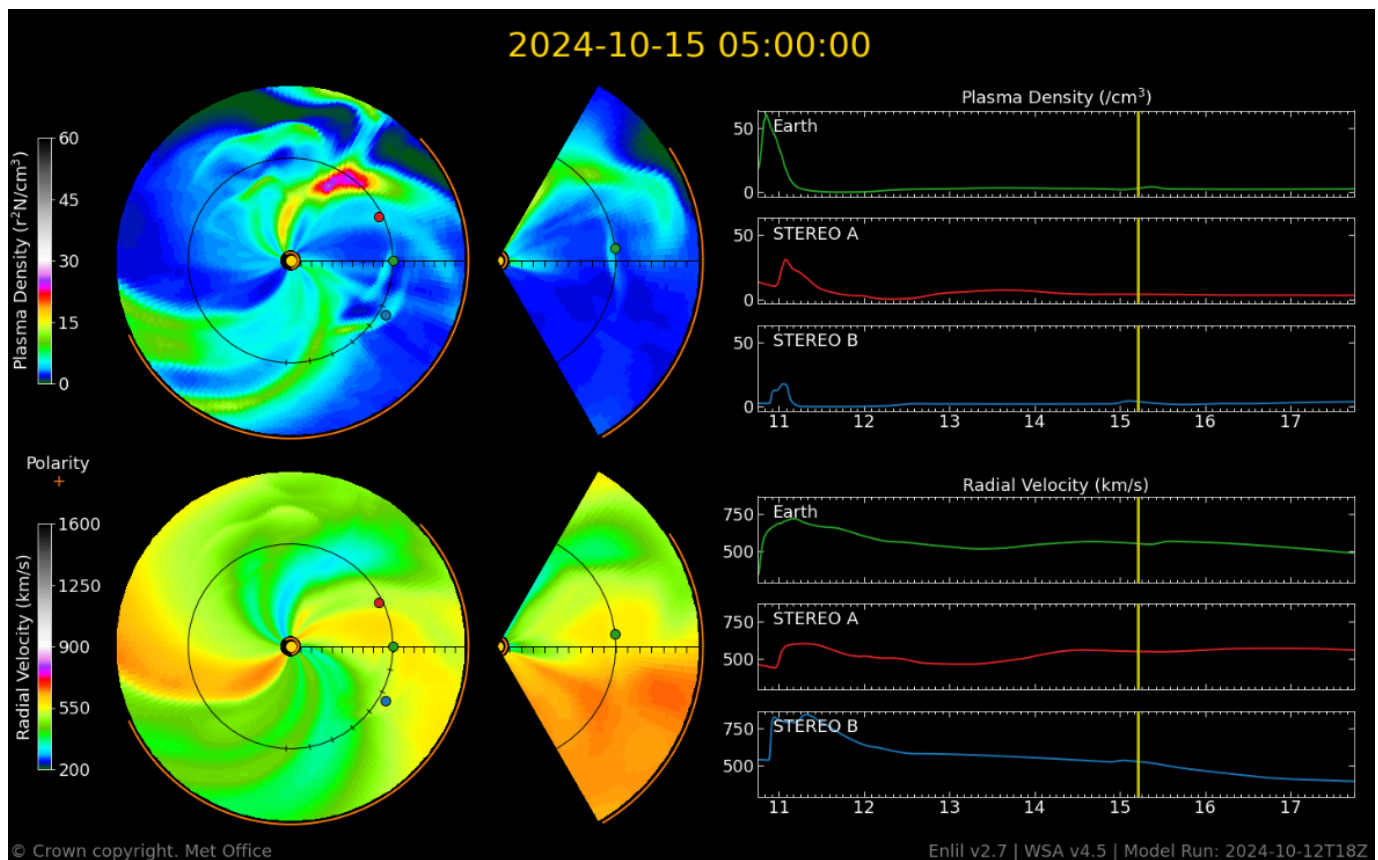
Quiet to Active conditions are expected to become mainly Quiet with isolated Unsettled intervals later day 1 (13 Oct) as solar winds continue to ease. Although a very slight chance of G1 Minor storms is maintained at first due the potential for any substorming effects. This continuing through the period, but with a chance of a spell of Active to G1 Minor Storm from any CME arrival on day 3 (15 Oct). There is also a slight chance of more prolonged fast wind enhancement from CH79/+, also on day 3 (15 Oct), which could also bring Active to G1 Minor Storms.

| Geomagnetic Storm           | Level    | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|-----------------------------|----------|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability<br>(Exceedance) |          |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Minor or Moderate           | G1 to G2 | Yes                       | 5                    | 1                    | 30                   | 5                    |
| Strong                      | G3       | No                        | 1                    | 1                    | 1                    | 1                    |
| Severe                      | G4       | No                        | 1                    | 1                    | 1                    | 1                    |
| Extreme                     | G5       | No                        | 1                    | 1                    | 1                    | 1                    |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time<br>21.5R <sub>☉</sub><br>(UTC) | Halo: Full<br>or<br>Partial | Source | Source<br>Location | Estimated<br>Speed<br>(km/s) | Estimated<br>Arrival<br>Time (UTC) | Comments                                    |
|------------------------------------------|-----------------------------|--------|--------------------|------------------------------|------------------------------------|---------------------------------------------|
| 12/0102                                  | Nil                         | AR3854 | 27E 01S            | 480                          | Early 15 Oct                       | Low confidence.<br>Glancing impact at most. |

**Figure 2: Enlil, showing slight enhancement from CME arrival. Low confidence, with Enlil over-estimating the strength of the solar wind to the south.**



## Radio Blackouts - X-Ray Flares

Low to Moderate activity is expected to continue with a likelihood of isolated M-class flares and a slight chance of X-class flares. These most likely from AR3848, or perhaps from the combination of AR3852 and AR3854.

There are seven sunspot regions currently on the Earth-facing disc. The largest of these is AR3848, the source of an X1.8 early on 9 Oct, but otherwise has been largely inactive. However, this persists as a region with strong magnetic flux, dominated by a large positive leader spot, with small negative polarity trailers to its north and south. The northern trailers currently appear to share penumbra with a small northward extension from the main positive spot, resulting in a weak and tenuous delta spot configuration. This region is becoming harder to assess however, as it is now approaching the northwest limb.

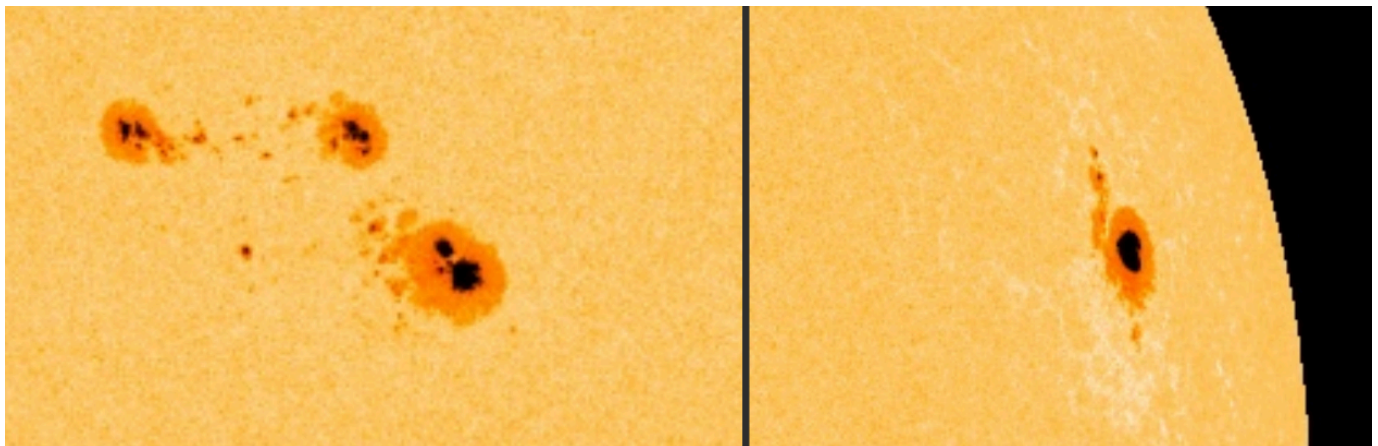
Elsewhere AR3852 and AR3854 form a cluster of two regions, just east of the south-centre disc. Despite being relatively simple bipolar groups, these have shown some limited growth in areal extent and are showing some magnetic interaction with the brightening of a flux rope between them in SDO imagery, likely due to the proximity of the positive intermediate spots of AR3852 and the leader of AR3854. AR3850 and AR3849 also form a close proximity cluster of regions in the southwest, but are smaller and simpler regions, primarily comprised as a cluster of negative spots, with much smaller positive trailers that have remained less persistent and often more pore like. The other two regions are newly developing regions, with one just west of the north-centre disc, and the other in the northeast.

| X-Ray Flares | Level              | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|--------------|--------------------|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability  |                    |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Active       | R1-R2<br>(M Class) | No                        | 70                   | 70                   | 60                   | 60                   |
| Very Active  | R3-R5<br>(X Class) | No                        | 15                   | 15                   | 10                   | 10                   |

**Figure 3: GOES-16/18 X-ray flux**



**Figure 4: SDO intensitygram of AR3854/52 (left) and AR3848 (right)**



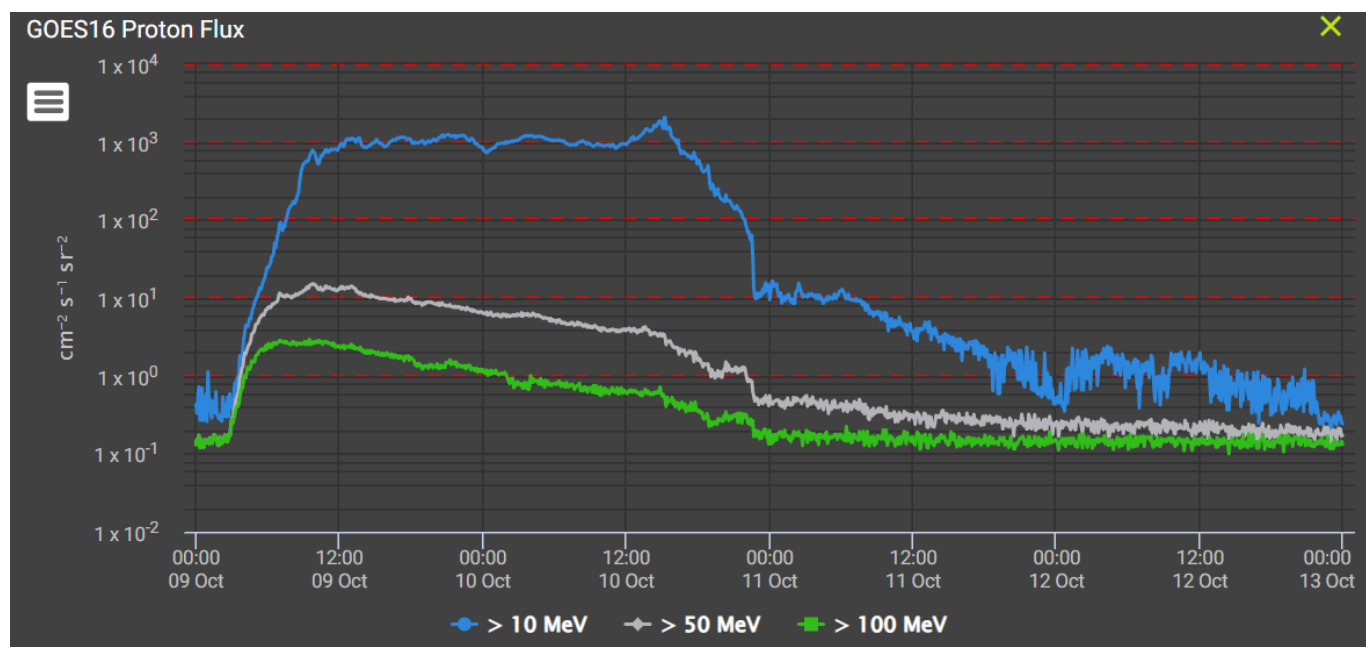
## Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is expected to remain at background, but maintains a chance of further enhancement given any further notable flares, primarily from AR3848, but also possible from any AR3852/54 combined flare, and cant be completely ruled out on day 1 (13 Oct) from over the limb from ex-AR3847 as it retreats onto the far side, however this is looking increasingly unlikely at this stage.

Any enhancement will bring a slight chance of reaching the S1 Minor Radiation Storm threshold.

| Radiation Storms                                                                                                                                    | Level<br>( $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$ ) | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability<br>(Exceedance)                                                                                                                         |                                                          |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Active                                                                                                                                              | $\geq \text{S1}$                                         | No                        | 15                   | 15                   | 15                   | 10                   |
| Very Active                                                                                                                                         | $\geq \text{S3}^*$                                       | No                        | 1                    | 1                    | 1                    | 1                    |
| * S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and/or $50 \text{ MeV} \geq 10 \text{ pfu}$ . (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$ ) |                                                          |                           |                      |                      |                      |                      |

**Figure 5: GOES 16 Proton Flux 09/0000-13/0000 UTC (Greater than 10MeV, 50MeV and 100MeV)**



**High Energy Electrons ( $\geq 2\text{MeV}$ )**

High energy electron flux (greater than  $2\text{MeV}$ ) as observed by GOES-16 is currently at Background to Moderate. The recent CME arrival and subsequent strong solar winds has likely increased counts at lower orbits, with the Van Allen belts compressed inward by the ongoing solar wind pressure. As solar winds ease, flux is expected to rise at GEO to become Moderate to High with a chance of becoming persistent High by day 2 onward (14 Oct). However, this is low confidence, and confidence is further lowered by the potential glancing CME arrival on day 3 (15 Oct). Any such arrival is likely to drop out the flux at GEO to background again, with any subsequent enhancement low confidence

The associated electron fluence is expected to be below the Active level ( $1\text{e}8$  total pfu), but with a rising trend. This will bring a chance of Active fluence, most likely day 2-3 (14-15 Oct) before the subsequent CME arrival reducing the potential for Active fluence. REFM is currently over-estimating the observed fluence, however this does show the potential for an increasing trend, once the solar wind pressure does ease.

| GEO Electron Environment    | Level<br>( $\text{cm}^{-2}\text{sr}^{-1}\text{day}^{-1}$ ) | Past 24 Hours<br>(Yes/No) | Day 1<br>(00-24 UTC) | Day 2<br>(00-24 UTC) | Day 3<br>(00-24 UTC) | Day 4<br>(00-24 UTC) |
|-----------------------------|------------------------------------------------------------|---------------------------|----------------------|----------------------|----------------------|----------------------|
| Probability<br>(Exceedance) |                                                            |                           | (%)                  | (%)                  | (%)                  | (%)                  |
| Active                      | $\geq 2\text{ MeV}$<br>$\geq 1\times 10^8$                 | No                        | 10                   | 25                   | 25                   | 10                   |
| Very Active                 | $\geq 2\text{ MeV}$<br>$\geq 1\times 10^9$                 | No                        | 1                    | 1                    | 1                    | 1                    |

**Figure 6: GOES-16 Electron flux and Fluence with REFM. Overestimation of REFM shown, but likely indicative of the rising trend expected.**

